



# Designing Enterprise Architecture for Gasoline Distribution Monitoring System Using IoT Technology

Adrian Kosasih<sup>1</sup>, Kevin Angriawan<sup>2</sup>, Gunawan Wang<sup>3</sup>, Nilo Legowo<sup>4</sup>

<sup>1,2,3</sup>Information Systems Management Department, BINUS Graduate Program-Master of Information Systems Management, Bina Nusantara University, Jakarta, Indonesia 11480.

<sup>1</sup>adrian010@binus.ac.id, <sup>2</sup>kevin.angriawan@binus.ac.id, <sup>3</sup>gwang@binus.edu, <sup>4</sup>nlegowo@binus.edu

## ABSTRACT

Energy Company is an enterprise that involved in the productions and sales of energy, including fuel extraction, manufacturing, refining and distribution. Currently, the company has problems in its gasoline distribution system to their oil merchants. Those are oil merchants that often run out of stock unexpectedly and un-synced reports because of untracked distributed gasoline amounts. Those problems need to be solved, because they are linked with the business process of Energy Company in general. This research's objective is to have Enterprise Architecture (EA) design for the gasoline distribution monitoring system, which will use the Internet of Things (IoT) technology implementation. Research data, among others problems and requirements for the gasoline distribution monitoring system, are obtained with observation and interview methods. This research has discovered EA design for the gasoline distribution monitoring system using IoT technology.

**Key words :** Enterprise Architecture, Internet of Things, gasoline distribution monitoring system.

## 1. INTRODUCTION

Energy Company is an enterprise that has its own gasoline distribution system. This research only focusing on company's gasoline distribution to their oil merchants. Over 5,000 oil merchants spread in almost every area in Indonesia. Energy Company's gasoline distribution system must be able to reach all of the merchants in those areas. However, there are some problems with the distribution system. The main problem is merchants often run out of stock unexpectedly. Customers can feel disappointed when they come to the gas station and meet this condition. This out of stock problem can decrease the proposition value of the company.

The other problem when using the existing gasoline distribution system is the calculation of the number of sales often unsynchronized, between the finance and stock department. The existing technology used, doesn't really help the Energy Company to get the right information. For example, the stock department counted 1,000 litres of gasoline distributed. But when the finance department receives payments, the amount of total payment is often under the payment it should receive for 1,000 litres of gasoline. So the company needs to be tighter in the gasoline distribution system.

According to the above problems, Energy Company's gasoline distribution processes need an accurate IT-based monitoring system. Enterprise Architecture (EA) becomes a strategy plan for enterprises or big companies to align their business and Information Technology (IT)[1]. EA design can be used by Energy Company to compare its business process, with and/or without IT. With EA design, Energy Company's top management can view and know the benefits of using a monitoring system based on IT.

Everyday in environment there are number of devices are being connected to one or many devices globally and many additional smart devices also correlate one another, hence people are now frequently joining smart IoT using these devices[2]. Company could use the benefit of IoT as an IT-based tool that's commonly used to analyze company businesses in the digital era. Big number of data can be gathered from the IoT technology, is often involved in decision making processes for enterprise businesses[3]. There are some ways for collecting this huge number of data. One of them is by using the Internet of Things (IoT) technology by implementing smart sensors[4]. The data directly can be collected by those smart sensors, then proceeded and used as information by the system's owner.

With IoT technology, there can be notifications for oil merchants when gasoline stocks are almost empty. Energy Company's financial and stock departments also can have accurate reports. So it can be the problem solver for the company to tighten their gasoline distribution system. Therefore, researchers need to design EA with the gasoline distribution monitoring system using IoT technology.

## 2. LITERATURE REVIEW

### 2.1 Enterprise Architecture

Enterprise Architecture (EA) gained a lot of attention for over the past few years and is being implemented by many organizations to help them dealing with the increasing complexity of their organizations' IT environments. In this matter, the use of EA can differ across organizations and have different meanings for both practitioners and researchers. EA is a description of the stakeholder mission which includes information, functionality or usability, organizational location and performance parameters. To develop a system or planning set of systems will be described in EA[5]. The main use of Enterprise Architecture

is to inform, guide, and limit decisions for organizations, especially in investing Information Technology (IT). The three main aspects of EA are business, information system and information technology architectures.

Business architecture can be described as all of the components within an organization, their relationship between them, and also their environment allowing them to achieve their objectives [6], while used as an instrument for organizational budget management for preparing future investment plans and their respective returns [7]. The goal is to align the processes with the IT resources, and will require the key component for achieving this objective is the team knowledge about the organization processes [8].

Data will play a key part as a link between the business and information technology department, therefore data architecture is required to be designed as based data architecture. Data architecture describes how data is collected, stored, transformed, distributed and consumed by human or machine. The 4 most thrilling aspects of data architecture are the physical manifestation of data, the logical linkage of data, the internal format of data, and the file structure of data[9]. Designing data architecture cannot be separated from application architecture, which is the structure and behavior of applications used in a business, focused on how they interact with each other and with users. Focused on the data consumed and produced by applications rather than their internal structure. In application portfolio management, the applications are usually mapped to business functions and to application platform technologies [10].

In order to support the data and applications in designing Enterprise Architecture, then a robust technological design is needed to support data and application needs. Architectural technology describing the capabilities which support business, data and logic software and hardware of application services deployed, including IT infrastructure, middleware, network, communication, processing, standard. By designing the information technology architecture will produce a plan or set of plans that guides the identification and utilization of the technical and human IT resources at the disposal of an organization [11] that enables the organization to successfully accomplish its business objectives.

## 2.2 Internet of Things

Internet of Things (IoT) indicates the network based interconnection of daily usage entities. It is termed as a self-organizing wireless linkage of devices aimed at the interconnection of everyday objects. It links with the wireless network through the interface by the electronic identifiers, sensors, two dimensional codes on things. Some applications that are built through use of IOT based technologies are very time sensitive and the performance of such networks as designed is one the most important bottlenecks[12]. The IoT technology helps to achieve the communication between human and machine or machine to machine. Three key features of IoT are considerable, intelligent and internet connective [13].

Some IoT implementations related to the oil & gas industry, by developing an IoT that collects data from connected devices in a secure, simple, reliable, robust and quick way. They suggested how the proposed model can be applied to the oil and gas industry in three categories, and the model can be achieved if the IoT devices are deployed based on cloud computing and this reduces the overall configurations. They proposed a model which supports the three oil and gas categories such as midstream, upstream and downstream, and other related processes in the oil and gas industry. They aim to solve and sort problems to save time and money besides increasing productivity with minimum human interaction [14].

When implementing IoT, users are able to change the business ability to measure and monitor any number of various devices, and this can be used with the oil and gas industry with the help of humans in the whole process. It also showed that IoT connected devices can report information in real-time with a high accuracy with the help of skilled humans. But the IoT application itself is designed to help humans monitor their systems. It concluded that the study with IoT can improve humans or people's powers to make a correct decision, minimizing the cost, improving the capability and for sure minimizing the risks.

## 2.3 Gasoline Distribution System

Gasoline reaches the consumer through a complex system that begins with extracting crude oil and transporting it to refineries, mostly via pipelines and barges. At the refineries, crude oil is processed into gasoline and other petroleum products. After it is refined, base gasoline is stored in large tanks until it is distributed via pipelines, ships and barges to distribution terminals located in and around major metropolitan areas. The gasoline is then transported again, usually via pipeline and barges to storage terminals for wholesale distribution. From there, it is shipped by truck to retail stations where consumers pull up to fill their tanks. Tanker trucks deliver fuel from the distribution terminal to service stations where it is stored in underground tanks.

The optimal distribution system in petroleum industry has been highlighted by many researchers. Some researches worked on gas supply chain involving producers[15], transportation companies, and local distribution companies. Also there researches investigated the maritime transportation of crude oil and petroleum products[16], designed supply chain model for a petrochemical complex system[17] and also recommended some ways for value preservation and value growth in oil industries[18].

## 3. METHODOLOGY

This research uses the observation method to obtain the research data. Observation starts by interviewing the General Manager of Energy Company. The methodology or steps used will be explained as follows.

### 3.1 Figure out Problems in Existing Business Process

For the first step, researchers need to know the details of existing business processes for the gasoline distribution

system at Energy Company. It is very important to know the existing business process, to figure out the main problems that need to be solved.

### 3.2 Gather User Requirements

After finding main problems in the gasoline distribution system, researchers try to gather user requirements to solve those problems. In this phase, researchers know that Energy Company’s top management needs an IT-based solution to make their gasoline distribution tighter with real-time information.

### 3.3 Design Gasoline Distribution Monitoring System

Based on user requirements gathered, researchers design the gasoline distribution monitoring system using IoT technology. The design illustrates the functionalities of sensors will be used, the main activities will be implemented and also shows the users’ roles in the IoT-based gasoline distribution monitoring system. So the measurement of gasoline amounts can be tracked real-time.

### 3.4 Design Gasoline Distribution Monitoring System

After the monitoring system designed, researchers try to design EA, based on the design of the IoT-based gasoline distribution monitoring system. The EA design describes business, information system and information technology perspective of architectures.

## 4. RESULT AND DISCUSSION

### 4.1 Problems in Existing Business Process

Researchers have gotten the existing business process of gasoline distribution overview, shown in figure 1 below.

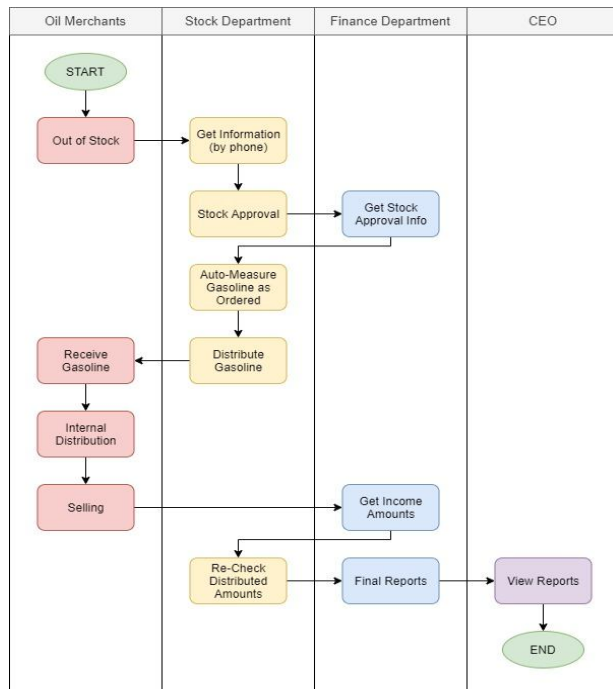


Figure 1: Activity diagram of the existing high-level distribution process

As seen in the existing gasoline distribution system, the only condition for merchants to get new gasoline stock distribution is when they run out of stock. Merchants contact the stock department for getting new stock. The stock department does the stock approval procedure with the finance department, to share the information of gasoline amounts will be distributed. Technology is being used for gasoline order auto-measure in the stock department. Then the gasoline stock is distributed into the Energy Company distribution containers tank. When the gasoline is filled into the containers tank, there is no technology inside the tank used to measure the gasoline amounts in real-time.

Next when the gasoline is being distributed to the merchants’ gas stations, the officers only use the usual gasoline transfer tools without doing measurement details. Although there are sensors in the merchants’ gas pumps, this kind of sensor is only used to measure the gasoline amounts when customers are buying and filling gasoline for their vehicles. The litres amount and the prices per litre of selling gasoline will be delivered to the finance department to be checked. Financial department then re-check with the stock department about the gasoline amounts distributed. The errors of report happen because the gasoline amounts randomly decrease, and it is hard to track.

When using the existing business process, there is a main problem found in Energy Company’s gasoline distribution system. That is when the merchants’ gasoline is unexpectedly out of stock. This problem occurred because there is no technology used in the gas stations’ tanks to measure the exact amounts of gasoline. When the gasoline is out of stock, that’s the only trigger for the Energy Company stock department to distribute new gasoline stock to the merchants in need. When requesting the new gasoline stock to deliver, there are some procedural processes that need to be done by merchants and the stock department. It can cause longer time for the gasoline distribution processes. This problem can be so bad when the demands are high, a lot of customers at the same time want to fill their vehicles’ fuel. If this problem happens very often, many customers will be more disappointed and turn to competitors.

The other problem is the real income amounts are often under the expected number of sales. So there are gaps between the finance and stock department’s income amounts calculations. At present, there is no real-time technology used to measure all of the gasoline amounts in the containers and merchants’ gas stations tanks. So if something happens with the gasoline tanks, all of the Energy Company departments would never realize. Either the tanks are leaking, evaporation, or other unexpected things happen. Related to those mentioned problems, the main point that needs to be noticed, Energy Company must tighten their gasoline distributor system. The company can lose some money because of those problems and a solution must be found immediately. There must be a real-time indicator to notify if something happens with the gasoline in the tank.

### 4.2 User Requirements

Researchers have gathered that Energy Company’s top management needs an IT-based monitoring system that can

be used anytime for measuring the real-time gasoline amounts in every merchant. So the IT-based monitoring system can make the gasoline distribution system tighter. With a real-time indicator, the company wants to have a better method of gasoline distributions. Better method of gasoline distribution means there is no need to wait until the gasoline is out of stock. The new monitoring system must indicate when the gasoline is almost empty in the merchants' tank. In result, the stock department can receive notification and immediately send the new stock of gasoline to the merchants' in need. The Energy Company wants to change their business process of their gasoline distribution system, by using an IT-based monitoring system.

The other requirement gathered is the company wants to improve their internal financial reports. With the IoT smart sensors in the gasoline tanks, the accurate data of gasoline amounts will be sent to the Energy Company head office. By detecting data in real-time, the finance and stock departments will receive the same income amount reports. The finance department can deliver the final reports immediately with high accuracy to the CEO. There will be no more differences of opinion and different calculations when delivering the final reports.

With those requirements, Energy Company needs a real-time gasoline amounts indicator in the end-to-end process of gasoline distribution system. The measurement of gasoline amounts can be monitored since the gasoline is distributed into the containers tank, then distributed into the merchants' gas station, selling them to the customers, until generating income reports based on the number of sales. The monitoring system needs an accurate and real-time technology provider to capture all conditions of merchants' gasoline amounts, because there are a lot of merchants of the Energy Company in Indonesia.

**4.3 Design of Gasoline Distribution Monitoring System**

Based on user requirements, researchers design the gasoline distribution monitoring system using IoT technology. The concept of this IoT-based monitoring system is the usage of sensors for measuring the real-time gasoline amounts. These sensors will be registered into the gasoline distributor containers tanks and in the merchants' gas stations tanks. Sensors' way of work is like the digital fuel meter in cars or motorcycles dashboard. The main difference is, the sensors used in the gasoline distribution system can inform the remaining amounts of gasoline in litres. So the stock department can monitor the gasoline amounts in every container tank and every merchants' gas stations tanks, for getting real-time information about the remaining gasoline.

**Table 1:** Sensors placements and functions

No.	Sensor Placements <sup>a</sup>	Functions
1	Gasoline distribution container tanks	<ul style="list-style-type: none"> <li>Show remaining gasoline amounts in the distribution processes (in litres) to the stock department</li> <li>Monitoring reduction of gasoline amounts when</li> </ul>

		distributing to merchants
2	Merchants' gas stations tanks	<ul style="list-style-type: none"> <li>Show remaining gasoline amounts for the merchants and the stock department (in litres)</li> <li>Notify merchants and stock department when the remaining gasoline almost empty (by setting default amounts to distribute new gasoline stock)</li> <li>Generate total sold gasoline amounts report for every merchant to stock and finance departments</li> </ul>

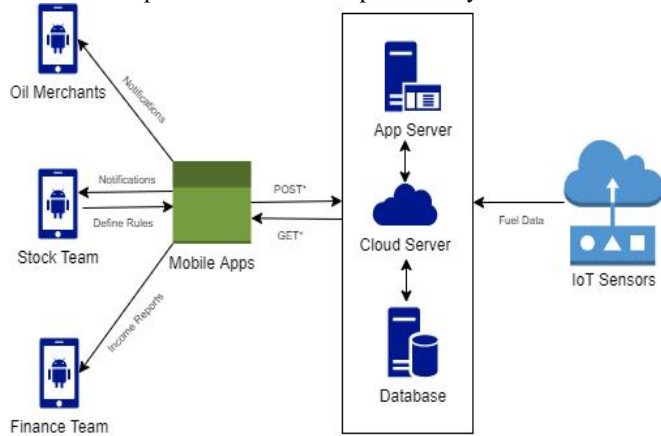
Those sensors' functionalities can provide convenience for the Energy Company head office and the merchants. Sensors in the gasoline distribution container tanks help the stock department to monitor the distribution processes, with knowing the remaining gasoline amounts in the tanks. Sensors in the merchants' gas stations tanks can give notifications to the head office, if merchants need new stock of gasoline. So when using IoT technology, there is no need to wait until merchants' gasoline is out of stock. The monitoring system can send notifications to the stock department when merchants' gasoline has reached the minimum limit. For example, we set the minimum limit of 100 litres for Merchant A in the monitoring system. When the gasoline reducing and remaining gasoline has reached 100 litres, the stock department will get notification to distribute the new stock of gasoline to Merchant A. This new workflow can prevent the Energy Company merchants from running out of gasoline.

IoT sensors in merchants' gas stations tanks, can help the stock and finance departments to have the right reports about the number of sales as shown in the table 2 below.

**Table 2:** Report per merchant generated by IoT technology

Date (dd/mm/yy)	Total Sold (Litres)	Price/Litre (IDR)	Amounts (IDR)
01/04/20	360.15	8,000	2,881,200
02/04/20	382.00	8,000	3,056,000
03/04/20	356.25	8,200	2,921,250
04/04/20	435.89	8,200	3,574,298
05/04/20	421.75	8,200	3,458,350
06/04/20	345.12	8,200	2,829,984
07/04/20	518.70	8,200	4,253,340
<b>TOTAL</b>	2,819.96		22,974,422

These reports that are provided from IoT sensors in merchants' gas stations tanks, can be filtered by date pickers. Finance and stock departments can choose the start date and end date as desired. With IoT technology, the Energy Company can measure the number of sales accurately. These reports can be the regular bases for making final reports, which should be given from the finance department to the CEO periodically.



\*) From Mobile Apps (users) point of view

Figure 2: IoT-based monitoring system framework

Can be seen in the figure 2 above, users from merchants, stock and finance department will use a mobile application to get notifications, and for stock team to define the rules of minimum limit of gasoline. All of data will be collected from the IoT sensors. Then data will be processed in a processing system that uses a cloud server that has huge application server and database. After data processed, mobile apps will receive the data. Oil merchants and stock team will receive notifications when there are some gasoline minimum limit condition to process the distribution. For finance team, they can generate report per merchant from their mobile apps. Special case for stock department, they can define rules like how much is the minimum limit in every merchant. In result, the distribution process will be started when there are minimum limit reached and collected from the IoT sensors.

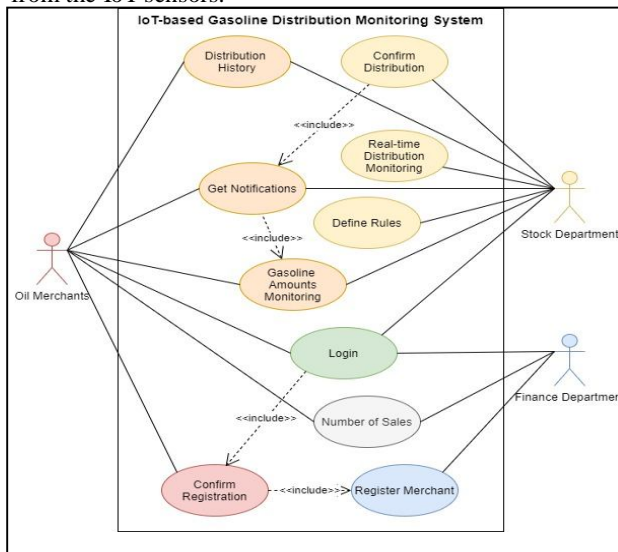


Figure 3: Use case diagram of IoT-based monitoring system

Above use case diagram describes the users' roles for all features in the gasoline distribution monitoring system using IoT technology. Stock department can monitor distribution gasoline amount, monitor merchants' remaining gasoline amounts, get notifications, confirm distribution and view all distribution history. Finance department can register merchants and get all merchants' number of sales. Merchants can confirm registration, monitor their remaining gasoline amounts, getting notifications, viewing their distribution history and their number of sales. Merchants have to be registered first by the finance department.

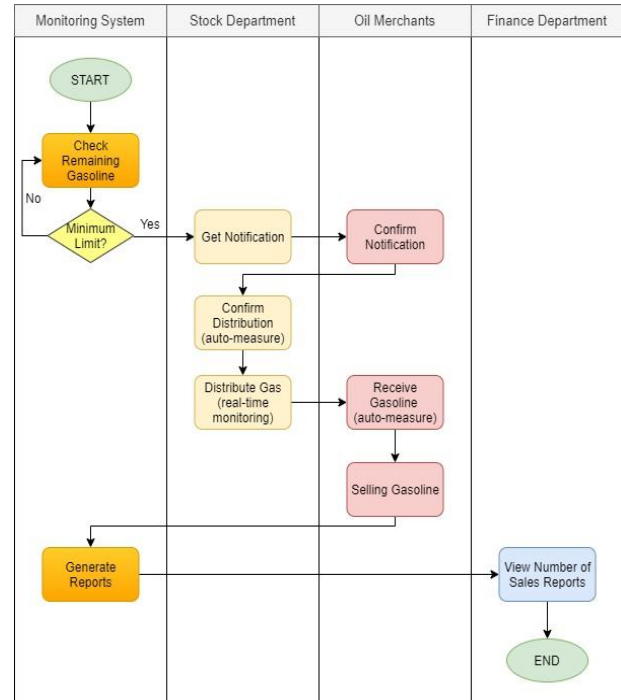


Figure 4: Activity diagram of the high-level distribution process using IoT

By using IoT technology, from previous activity diagram, can be seen there are some main differences with the existing business process:

- The notification for distributing new stock will be triggered when gasoline amount meets the minimum limit in one or more merchants.
- The stock department can monitor the amount of gasoline during the distribution process.
- The auto-measurement process that runs with IoT technology can ensure that the amount of gas transferred from containers to tanks at merchants' gas stations is exactly the same amount.
- Finance department no need to recheck the number of sales, because it is already systemized and accurate from the beginning process.

Those differences should produce positive impacts for the Energy Company. The overall gasoline distribution process becomes shorter and has more precision.

Mobile application will be used for users to access the monitoring system. The benefits of using the mobile application, it's easier to access and have quicker response to notifications. So, communication between teams that are



involved in the distribution system can act faster and more responsive.

#### 4.4 The Design of Enterprise Architecture

There are several things that must be noticed before researchers design the Enterprise Architecture (EA). The EA design must include business, information system and information technology architecture, because an EA design must contain those perspectives needed. The design tells the details in each aspect of architecture, including how to have a good standard of quality management for the technology architecture. So not only planning and developing the IoT-based monitoring system, maintenance the quality of tools, data, application, and resources will be pictured in the EA design.

In business architecture, the main point is the evolution of the business process. Significant changes can be seen on the stock department when distributing new stock of gasoline based on notification. From the business point of view, preventing merchants from running out of stock can make selling processes keep rolling. This condition will have good impacts for Energy Company and customers. For Energy Company, the number of sales increasing compared to the existing business process. In the existing business process, run out of stock condition will cost more time to distribute gasoline from the stock department to merchants in needs. In

this stage, the company business is disrupted. With IoT technology, that condition can be prevented because merchants always have ready stock. And for customers, they will always get their needs when they go to the merchants' gas stations. It will improve customer satisfaction and loyalty.

Information architecture supports business architecture, by using information given from the technology in use (IoT sensors and internet). In information system architecture, internal users can do monitoring the distribution processes and get the summary from collected information. In information system architecture, data architecture will define the rules of all processes in the IoT-based monitoring system. Some created rule being used to process all sensor data to become information that will be utilized for sending notifications. Either when reaching the minimum limit to distribute new stock and/or when there are gasoline-decreasing conditions. In the end all information will be process for generating the number of sales reports. Application architecture becomes the connector between data and information technology architecture. This architecture will be the user interface for receiving and sending data or information. The delivery of information will be provided via mobile application as the platform of application architecture. Users involved in information system architecture are merchants, stock and finance departments.

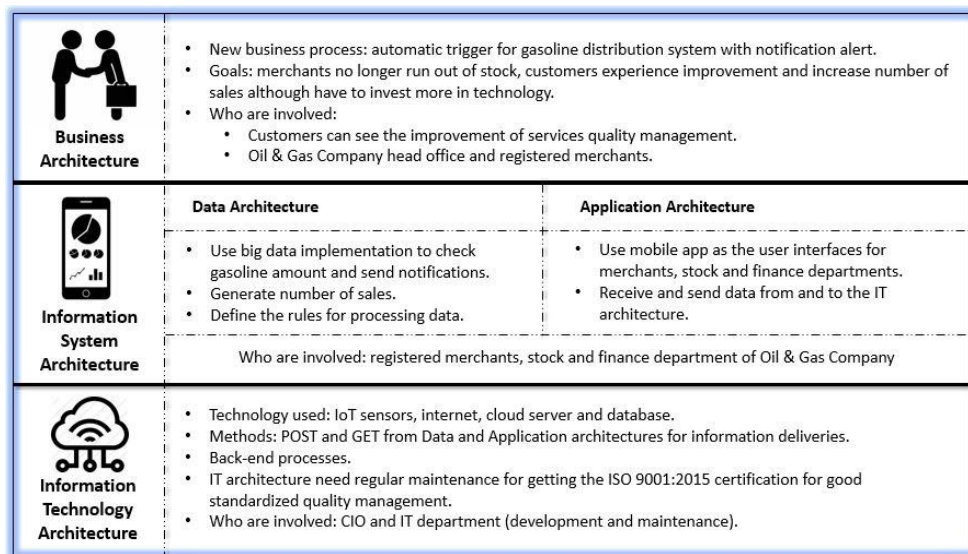


Figure 5: EA design for IoT-based gasoline distribution system

Technology or information technology architecture is the “builder” in this Enterprise Architecture design. IoT sensors, internet, cloud server and database are the main tools that are used to build the gasoline distribution monitoring system at Energy Company. Without those technologies, the new business process will not work. The functionalities of technology architecture are to collect (from IoT sensors), process the data into some information and send those information to the mobile application used by merchants, stock and finance departments. The data will be obtained using IoT technology with sensor capability registered in the containers and merchants' gas stations tanks. Before data

being processed, the stock department has to define some rules to be processed and becomes useful information for users to make the right decisions.

The maintenance of technologies is so important for the Energy Company to get good standardized quality management. Since system accuracy and precision are depending on the quality of the tools. For example, the IoT sensors accuracy for long term needs to be maintained frequently. The accuracy of sensors for getting the remaining gasoline amount data, is the critical point for the IoT-based monitoring system. If sensors don't work

properly, collected data or information will not accurate. If the data are not accurate, users have a higher possibility to make wrong decisions. Of course, Energy Company's top management will not let this happen. That's the main reason why maintenances are also included in the technology architecture in EA design.

## 5. CONCLUSION

The design of Enterprise Architecture (EA) for Energy Company, gives visibility to company by mapping requirements for distribution monitoring system and the role of each department in order to enhance their distribution monitoring system. In order to prevent oil merchants running out of gas and also get accurate sales report, the Energy Company need to take advantages by using IoT technology.

From business perspective, Energy Company able to increase their sales productivity and customer loyalty. In system information perspective, Energy Company can be more responsive for distribution towards merchants. And last from information technology perspective, can increase the effectiveness of using IoT technology to support accurate information delivery.

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